the winter months, none of these equals the work done by the *Aurora*, and none of the masters has hitherto given us more than a summary of his investigations.

An early chapter deals with Macquarie Island, that queer ridge of glaciated rock which may be described as a tile set on edge athwart the wild west winds. All round this dependency of the Commonwealth the *Aurora* made soundings which revealed the profundity of the depths surrounding it. Then we are told of the mysterious Royal Company Isles which were "discovered" in 1776 by a Spanish captain about 400 miles south of Tasmania. Unfortunately for the Spaniard, Davis sailed right across the alleged position of these islands, which must now disappear from the charts. Another interesting chapter deals with the Auckland Isles to the south of New Zealand. We should have liked more particulars of the castaways and settlements which have enlivened the history of these desolate subantarctic islands.

In November, 1912, Davis was dredging 250 miles south of Tasmania when his apparatus was carried away by what may best be described as a crag of a "drowned Tasmania." Rising 8,000 feet above the ocean floor he found a large plateau, "Mill Rise," which raises interesting questions as to a former connection between Australia and Antarctica.

The most vital chapters in the book deal with his hazardous voyages along the icebound coast of Antarctica. The reviewer has spent many months sledging in the Antarctic and has had some slight experience of aviation, but for supreme danger and discomfort he places easily first a cruise among the bergs in the twilight of a polar autumn. Yet this was a commonplace to Captain Davis—the most experienced navigator of Antarctic waters. We read much of the treachery of the famous blizzards. For instance, while waiting to take off Mawson's party at the main base, the *Aurora* was anchored a short distance from the shore. The boats had just taken advantage of a period of calm to land some stores. Suddenly a single terrific gust struck the ship, snapped the anchor chain, and blew the *Aurora* far to the north.

A typical account of the weather describes the day when Mawson was successfully picked up. "At 8 A. M. the land became invisible owing to the driving spray and drift. At 10 A. M. the wind averaged about 70 miles an hour, with squalls of terrific violence. At 11 it reached the strength of a hurricane, the sea was cut off almost flat by the force of the wind. The glass has fallen three-tenths of an inch." We are not surprised that the *Aurora* broke two anchors and lost three others in these tempestuous seas.

Later chapters describe the variations in the ice pack off Antarctica. It is most interesting to know that 1914 was marked by an unusually wide and unbroken belt of pack ice. Is it not possible that this greatly affected the temperature of Australian waters and was a vital factor in determining the great drought of that year? In this section the book is specially well illustrated with sketch maps.

Davis is generous in his praise of the French and American expeditions of 1840. There is a full appreciation of the heroic struggles of Lieutenant Wilkes, Davis following stage by stage the gallant voyages of the sailing ship *Vincennes* in these perilous seas. A series of comparative charts show that the old sailing vessel has rarely been beaten even in these days of steam. We learn that Côte Clairie of the French turns out to have been merely Ice Barrier, for the *Aurora* sailed nearly 100 miles south of this. Here she discovered a new land to which the Australians gave the name of Wilkes Land.

In the last chapter Davis sounds a note of warning: "To the explorer who has not the money to provide good equipment of every kind, my advice is—keep out of the Antarctic!"

GRIFFITH TAYLOR

A TEXTBOOK OF METEOROLOGICAL PHYSICS

W. J. HUMPHREYS. **Physics of the Air.** xi and 665 pp.; maps, diagrs., ills., index. The Franklin Inst. of the State of Pennsylvania. J. B. Lippincott Co., Philadelphia, 1920. $5.00. 9½ x 6½ inches.

The foremost aerographer of Europe in the preface to his "Manual of Meteorology" (1919) said,

"The physical and dynamical principles upon which the processes of weather depend are the common property of all students of physics. If those to whose care the progress of physics is entrusted had taken the physical problems of the atmosphere under their charge as their predecessors did before the advent of the electrical era, one-half at least of this book might have been more effectively dealt with by other hands."

"Physics of the Air" may well be regarded as an answer to this indictment of physicists for neglect. In part it meets the demand of aerologists for a special, up-to-date treatise. But here a strange condition of affairs confronts one. For physics today is not the established, slowly changing physics of a few years back; but a more complex and rapidly changing study of the structure of the atom, modifying views heretofore held as fundamental in astronomy, biology, chemistry, geology, and mechanics.

In fact the favorite occupation of physicists now seems to be "giving a jolt" to classical dynamics. One may not reasonably then expect a book on physics to be strictly up-to-date; unless the volume comes hot from the press. Where publication is delayed a technical treatise is sure to suffer. In the present book one looks in vain for recent determinations of Planck's constant, the value of the electron charge, molecular weights, and atomic numbers.

Professor Humphreys states that the book is an attempt to present "an orderly assemblage of facts and theories connected with the physics of the earth's atmosphere." Mechanics might well be added. The volume originated in a series of lectures delivered at an aviation school in 1914; and these have been expanded, revised, and from month to month printed in the *Journal of the Franklin Institute*, 1917–1920. Many of the diagrams and much of the text are reproduced with slight changes from articles by the author and others in Weather Bureau publications.

There are four parts: I, Mechanics and Thermodynamics; II, Electricity and Auroras; III, Optics; and IV, Factors of Climatic Control.

The book is rather weighty; too large, we think, for convenient handling; but this is doubtless because of the extent of the field covered. Would it not have been better, to have excluded, as far as possible, the chapters on Vulcanism, which are geophysics rather than aerophysics? Part IV, as the author says, "is a discussion of the physics of climate but not of its geographic distribution" which is Hamlet with Hamlet omitted. The subject is one of such importance and of so much interest to others beside meteorologists that we venture to express a hope that Professor Humphreys will amplify this portion of the book in a separate volume, to be called perhaps "Evolution of Climate."

Part II, entitled "Atmospheric Electricity and Auroras," consists of two chapters, nineteen pages. Would it not have been more appropriate to include under Part II, Chapters XV and XVI on Thunderstorms and Lightning now in Part I? More especially so, because Part I is disproportionately long, consisting of sixteen chapters, four hundred twenty-five pages, a book in itself.

Part III deals exhaustively with optical effects, and is drawn chiefly from Pernter and Exner's "Meteorologische Optik," supplemented by some of the papers of the former Lord Rayleigh published in the *Philosophical Magazine*. Here the work of a distinguished American (Barus) on Nucleation has apparently been overlooked. Refraction phenomena are dealt with at great length. There is an interesting explanation of the "green flash" as a refraction effect.

On page 448 is an amusing paragraph with the fine flavor of a problem in relativity: "It is conceivable therefore, that the size of a planet and the vertical density gradient of its atmosphere might be such that one's horizon on it would include the entire surface—that he could look all the way round and, as some one has said, see his own back." Some doubting Thomas will at once ask, "What kind of a temperature distribution could produce such a density lapse rate?"

Looming, towering, sinking, and stooping; also superior and lateral mirage are terms used and defined; and we suspect that some of these are freshly coined. There is, however, no specific definition of visibility, nor its complement obscuration; or tables such as are now used at aviation centers.

The volume being quasi official, a wider range of criticism may be permitted than ordinarily would apply; and so we feel forced to point out that Chapter I, headed "Observations," is of a prewar order, not up to the requirements of the present time and certainly not up to the high level of the rest of the book. There are time-worn illustrations of a Robinson anemometer and a sling psychrometer but only the barest mention of Dines' pressure-tube anemometer and the modern humidity instruments. To be sure, elsewhere in the book a pressure-tube anemogram is given to illustrate gustiness; but, even then the record is an old one [Aberdeen, January 6, 1908], in fact one of the earliest, one in which the wind direction is not automatic but is added by hand. So many excellent anemobiograph records are available that the selection must be regarded as inadequate.

It may also be noted that the reference given on page 221 to this pressure-tube trace is

erroneous; as Figure 31 is an assumed temperature gradient. A minor error occurs on the same page regarding billows in the low atmosphere and pressure changes of 0.1 mm. to 0.3 mm. Figure 57 is an old-fashioned scale in inches, not millimeters as the text requires. Again, the elevation of the station is omitted; and so we have the incongruity of a pressure curve representing an anticyclone in which the pressure reading is 29.05 inches. On page 227 the scales are again confused.

In the discussion of tropical cyclones, no mention is made of the work of Algué, Froc, or Fassig; and one looks in vain in the index for "*baguio*," "hurricane," and "typhoon"; and yet "bumps" is duly given. The work of Bigelow, Barus, both Bjerknes, Cave, Dines (J. S.), Dobson, Eiffel, Margules, Rotch, and many others is not mentioned. Certainly Bjerknes's graphic methods of dynamical meteorology and Bigelow's explanation of the origin of cyclones, whether accepted or not, should have been referred to; as well as the various papers of the latter on circulation and radiation in the atmosphere.

Some confusion exists in the use of units and symbols. R for example, is employed as symbol for gas constant, ohmic resistence, radius of rain-drop, radius of the earth, rain, and resultant amplitude. In general Professor Humphreys keeps closely to the Centigrade scale and C. G. S. units. In formulae for gradient winds, pressure differences are expressed in dynes per square centimeter which is now becoming general in aerographic literature. But, notwithstanding this, the meteorological bar is used and not the bar of the physicist.

ALEXANDER MCADIE

THE PREDICTION OF MINIMUM TEMPERATURES

J. WARREN SMITH, AND OTHERS. **Predicting Minimum Temperatures from Hygrometric Data.** 76 pp.: maps, diagrs., ills., bibliogr. *Monthly Weather Rev. Suppl. No. 16.* U. S. Dept. of Agriculture, Washington, D. C., 1920.

The need for predicting minimum temperatures is imperative in fruit regions where the growers must protect their crops against freezing. But fruit growers cannot afford the expense of protection every time the temperature *may* fall dangerously low; so an accuracy of prediction within two or three degrees (F.) is practically required when temperatures in the twenties are expected. Since most methods of protection are useless on windy nights, profitable fruit growing is confined to regions where at critical seasons the temperatures do not fall much below freezing except on clear, quiet nights. The forecaster's problem, then, is to pick, from weather map indications and the local aspect of the sky, the nights which will probably be clear and then to compute how low the temperature will fall. Under clear skies the rate of cooling is closely dependent on the moisture content of the air—dry air favoring strong radiation and a large fall in temperature. Thus, observations of humidity in the afternoon or evening can be used to predict accurately the next morning's minimum temperature when a clear night with but little wind is expected.

This collection of papers, prepared under Professor Smith's guidance, shows in detail how hygrometric data are used in actual practice in different fruit regions. Graphical and statistical methods brought into action insure the employment of the best means and the greatest accuracy at present attainable. The observations of a central station in a fruit region can be used for predicting minimum temperatures at places even several miles away, once the usual temperature differences between the central station and the outlying locality are known. Thus, if the central station has some years' length of record, only a few months' observations in different orchards are necessary before accurate local temperature forecasts are possible.

Aside from the discussions centered about the use of hygrometric data, two contributions deserve special mention. On pages 20–30 Dr. H. J. Franklin has presented a detailed discussion of "Cape Cod Cranberry Frosts," how forecast, the temperature resistance of cranberries in different stages, and ways to protect bogs from frost. On pages 46–49 Mr. J. Cecil Alter discusses "Forecasting Minimum Temperatures in Utah" especially "for sheep shearing and lambing and fruit-raising interests in spring; alfalfa seed, tomato, and vegetable interests in autumn; and shippers of perishable products and users of stream flow for hydroelectric purposes in winter." . . .

A specialized bibliography of 12 titles closes the group of papers.

CHARLES F. BROOKS